KING COUNTY

Department of Natural Resources

KING COUNTY BULL TROUT PROGRAM
2000 BULL TROUT SURVEYS

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June 2001

"The members of this genus (Salvelinus) are by far the most active and handsome of the trout, they live in the coldest, cleanest and most secluded waters. . .No higher praise can be given to a Salmonid than to say, it is a charr."

-Jordan and Evermann 1896

EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service (USFWS) listed Coastal / Puget Sound bull trout as Threatened under the Endangered Species Act (ESA) November 1, 1999 (Federal Register 1999). Under this listing the USFWS assumes the presence of bull trout in King County waters, unless proven otherwise. In response to this requirement, the King County Department of Natural Resources (KC DNR) implemented a Bull Trout Sampling Program in 2000 to identify existing bull trout populations and habitats in King County waters.

In the Puget Sound region there are fifteen subpopulations of native char, including both bull trout (*Salvelinus confluentus*) and Dolly Varden (*S. malma*) forms (King County 2000). The term "native char" refers to bull trout and Dolly Varden collectively. Native char have coexisted with salmon and steelhead by occupying a different niche, while relying upon the salmon as food (Meehan and Bjornn 1991). In King County, known populations of self-sustaining native char occur in the Skykomish, Cedar, and White River basins. Confirmed sightings in the marine environment suggest that these fish might be using Puget Sound for foraging and migrational purposes (Armstrong 1974; Cavender 1978; Haas and McPhail 1993).

Sampling for native char can be very difficult given their cryptic behavior and very low population densities (Hillman and Platts 1993; Thurow 1994; Watson et al. 1997). The KC DNR began a pilot-sampling program in 2000 for the purpose of detecting native char in King County waters using a highly specialized protocol developed specifically for the detection of these species by a coalition of fisheries biologists from federal, state, and local agencies, and the private sector.

The goal of this pilot-sampling plan is to sample areas with suitable habitat for bull trout spawning and rearing but where the occurrence of self-sustaining populations of native char has not been proven. King County implemented the protocol developed by the American Fisheries Society for the detection of both juvenile migratory and stream-resident char. This sampling protocol is supported by USFWS for the determination of whether or not native char species are "present" in a particular watershed or at a given site.

In the fall of 2000, King County fisheries biologists sampled the three forks of the Snoqualmie River above Snoqualmie Falls for the presence of native char. In this sampling exercise, rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*O. clarki*), rainbow and cutthroat hybrids (*O. clarki x O. mykiss*), sculpin (*Cottus spp.*), and brook trout (*Salvelinus fontinalis*) species were encountered, but neither species of native char was detected. Reconnaissance efforts in 2000 also identified sample sites in the Green River Watershed and in the Issaquah Creek Basin, for similar surveys to occur in subsequent years.

Under the ESA, King County is responsible for protection of listed species that reside within its jurisdiction. It is imperative that resource managers know where and when bull trout are found in King County in order to comply with federal and state conservation and recovery mandates. All King County departments addressing issues of development, transportation, and natural resources need this information to ensure that operating procedures are protective of listed species. Importantly, knowing those habitats where bull trout are not expected could alleviate ESA concerns with regards to the viability of large-scale capital projects such as sewage treatment plants, bridges, and transportation projects. By understanding the spatial and temporal distribution of bull trout in King County waters, the permitting and project elements can be designed to avoid further harm and enable recovery of the species. We currently perform biological assessments, apply for Section 10a1A permits, and conduct Section 7 consultations in areas where bull trout are *assumed* to be present by USFWS. A systematic sampling program will allow an understanding of this assumption and could save a considerable amount of resources. At the same time, King County is providing an excellent example for other jurisdictions working under the ESA, by cooperating with USFWS and taking a proactive stance in evaluating the status of these species in King County waters.

INTRODUCTION

Native char of Washington include both bull trout (*Salvelinus confluentus*) and Dolly Varden (*S. malma*) forms. Until 1978 bull trout were considered to be an inland form of Dolly Varden, but not a separate species. Cavender (1978) determined that bull trout and Dolly Varden are distinct species based upon genetic analysis. In many instances, especially historical references, native char observations have not distinguished between bull trout and Dolly Varden and for simplicity in this document we refer to both species as "native char".

Spawning and Rearing

Native char exhibit complex life histories, and have very specific habitat requirements for spawning and rearing. Spawning of native char generally occurs from September through November (Goetz 1989). Wissmar and Craig (1997) found that bull trout in higher elevation areas of the Cascades (greater than 3000 feet) begin spawning as early as August. Bull trout depend upon water temperatures below 9°C to begin spawning (McPhail and Baxter 1996), which generally limit their spawning habitat to snow-dominated, and/or spring-fed streams (Goetz 1997).

Bull trout eggs require long incubation periods, making redd site selection very important. Bull trout eggs hatch between 51 and 126 days with warmer water requiring less time than cold water. Bull trout and Dolly Varden eggs require very cold water for successful incubation, with optimum temperatures between 2 and 4 degrees Celsius (Goetz 1989). Long incubation periods make spawning site selection especially important for bull trout. Changes in geomorphology can have dramatic affects on redd success. It has been shown that, for example, that shifting gravel can crush incubating eggs (Furniss et al. 1991; Baxter and McPhail 1997). Likewise, the accumulation of fine sediments in interstitial spaces of redds can suffocate developing embryos (Furniss et al. 1991).

Emergence of bull trout fry typically occurs in the late spring, and these fish may stay in their natal stream for 1 to 4 years (Baxter and McPhail 1997). This extensive rearing requirement is often the limiting factor for a bull trout population, and it is widely understood that a lack of rearing habitat limits the potential recruitment of reproducing adult fish (Faush 1984; Goetz 1994; Lacroix et al. 1995). Bull trout typically reach sexual maturity between five and seven years of age (Goetz 1989; McPhail and Baxter 1996; King County 2000).

Life History Strategies

Bull trout and Dolly Varden utilize several life history strategies including stream-resident, fluvial, adfluvial, and anadromous (amphidromous) forms. Stream-resident fishes spend their entire lives in their natal streams, and do not grow much larger than 300 mm in length (Goetz 1989). Fluvial fish migrate from their natal streams to larger river systems, and then migrate to their natal waters for spawning purposes. Fluvial fish can get much larger than stream-resident fish due to the foraging potential in these larger systems, with some fish attaining lengths in excess of 800 mm (Goetz 1989). Adfluvial fish rear in streams and river systems, and then move to a lake environment. Adfluvial fish can attain lengths in excess of 700 mm and weights in excess of 5 kg (Goetz 1989; Thurow 1994; Ratliff et al. 1996). Anadromous or amphidromous char migrate to the saltwater environments as sub-adults, and return to freshwater streams for spawning purposes (Armstrong 1974; Bjornn and Reiser 1991). Very little is known about these marine migratory bull trout, although Dolly Varden are known to exhibit this behavior in coastal areas in British Columbia and Alaska (Armstrong 1974). It is common for marine migratory fish in the Puget Sound to grow in excess of 650 mm and 5 kg, since the forage potential in estuary and saltwater environments is extensive. Figure 1 depicts the four life history strategies of bull trout, which can be applied similarly to Dolly Varden.

FIGURE 1

LIFE CYCLE AND LIFE HISTORY STRATEGIES OF BULL TROUT AND DOLLY VARDEN

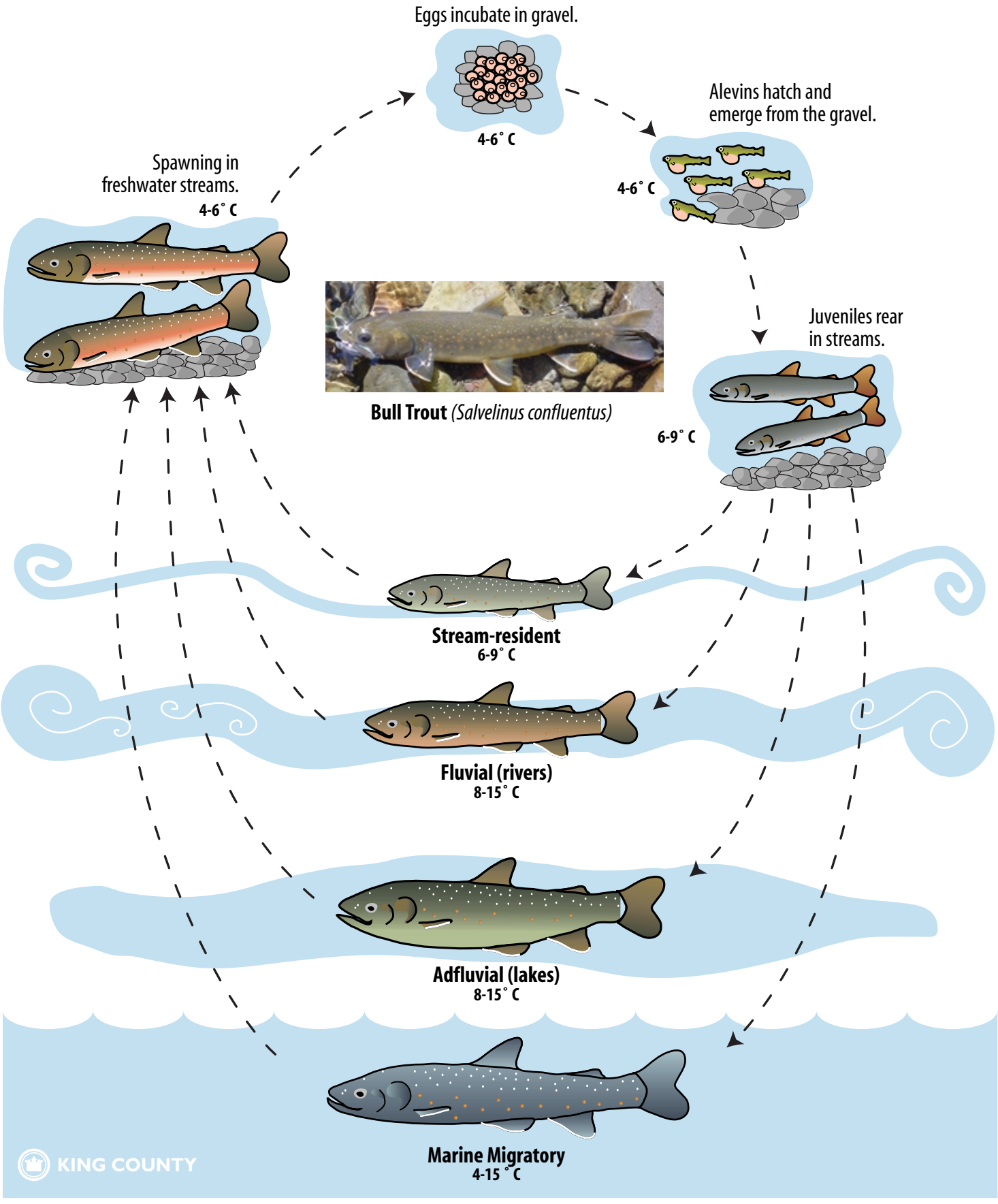

Photo Credit: Lost River Ranger District Salmon-Challis National Forest

Current Threat

Bull trout may be particularly susceptible to extinction, due to several confounding life history strategies (Rieman et al. 1997; Vucetich et al. 2000). Stream-resident and fluvial bull trout exist in relatively low densities, require very specific habitats (cold water, deep pools, stable flows, etc.), have highly fragmented populations, have a late age of sexual maturity (4 to 5 years), and have particularly long incubation times (Bjornn 1961; Goetz 1989; Watson et al. 1997). Additional risks to survival include fishing pressure, competition from non-native fishes, and both natural and anthropogenic disturbances can greatly increase the risk of extinction to these species (Rieman and McIntyre 1993). The future persistence of bull trout will depend upon the extent of habitat degradation, competition from exotic species, and isolation from other populations (Rieman et al. 1997).

BACKGROUND

In the Puget Sound region there are fifteen subpopulations of native char, including both bull trout and Dolly Varden forms (King County 2000). The term "native char" refers to bull trout and Dolly Varden collectively. In King County, known populations of self-sustaining native char occur in the Skykomish, Cedar, and White River basins. Observations of native char in King County (Figure 2) have been recorded in the Tolt River, Issaquah Creek, the lower Cedar River (below Landsburg), Lake Washington, Lake Sammamish, Shilshole Bay, the lower Green River, and the Duwamish estuary (King County 2000). These observations do not necessarily indicate a self-sustaining population, as these fish exhibit complex migrational strategies, including a marine component that is not widely understood.

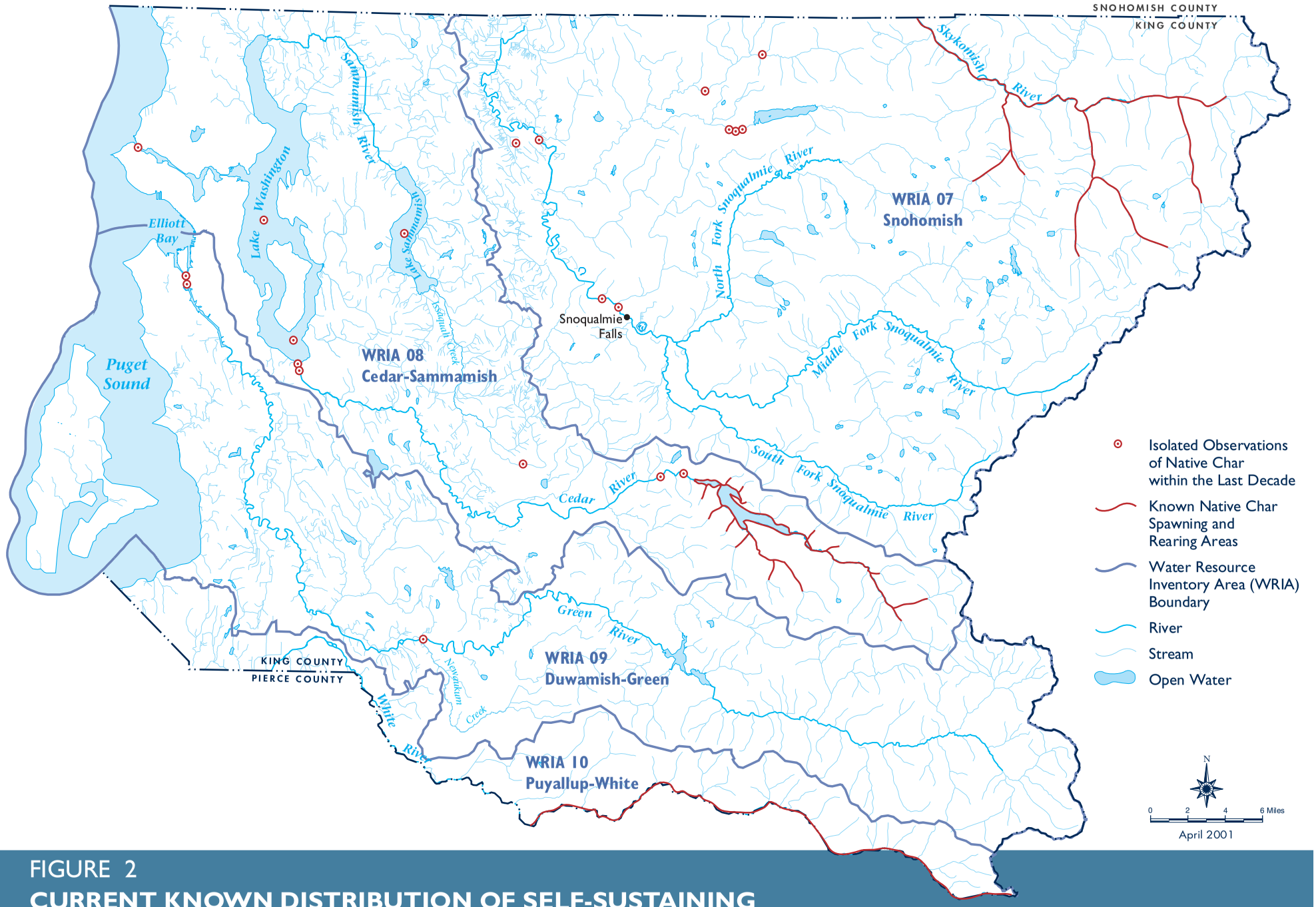

FIGURE 2

CURRENT KNOWN DISTRIBUTION OF SELF-SUSTAINING NATIVE CHAR SUBPOPULATIONS AND ISOLATED OBSERVATIONS OF NATIVE CHAR IN KING COUNTY

KING COUNTY

Produced by: GIS & Visual Communications Unit, Department of Natural Resources
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Due to the complex life history adaptations exhibited by bull trout, many sampling protocols have been implemented throughout their range, with a variety of techniques (Watson et al. 1997). Different sampling strategies have different efficiencies based upon the habitat where they are applied, and the life history stage that they are trying to detect. Bull trout are generally found near the substrate in a stream channel, and are cryptic in nature (Thurow 1994). Juvenile bull trout are especially found on the bottom of the stream, often in between cobbles and boulders on the stream bottom, and in woody debris complexes (Bonneau et al. 1995; Thurow 1994). These orientations can make it especially difficult to enumerate these fishes. During nocturnal periods bull trout move from these areas to forage in the water column, which makes nighttime observations a better choice than daytime observation (Bonneau et al. 1995; Goetz 1994). If daytime observations are necessary, bull trout are generally more active when water temperatures exceed 9°C (Thurow 1997).

It is because of these complexities that bull trout sampling plans generally rely upon several techniques. Night and day snorkeling, electrofishing surveys, and various trapping methodologies are used in combination to assess bull trout populations and detect presence in questionable waterways. Electrofishing is generally the best method for detection of bull trout juveniles, but this is not necessarily true for adults (Goetz 1994). Night snorkeling is less invasive than electrofishing, and can be just as effective as electrofishing in determining presence of adult bull trout, especially in areas of low conductivity (Thurow 1997; Bonar et al. 1997; Bonneau et al. 1995). Day snorkeling is less efficient than either night snorkeling or electrofishing, but can be used where safety is a concern or in areas where electrofishing is not a viable alternative (Peterson et al. 2000).

In order to assess the efficiency and to statistically validate this approach, several different protocols have been developed. All of these protocols make assumptions about the threshold density exhibited in these populations. Thurow and Schill (1996), Hillman and Platts (1993), the American Fisheries Society (Peterson et al. 2000) and WDFW (Bonar et al. 1997) have developed statistically based sampling strategies with their own advantages and disadvantages. These protocols are written for sampling in lotic systems only, and should not be applied to lentic or marine environments. Figure 3a shows the sampling efficiencies assumed by the authors in each of these protocols.

Figure 3a. Assumed sampling efficiency of different methodologies for the detection of bull trout

ASSUMED SAMPLING EFFICIENCIES FOR BULL TROUT PRESENCE	
Hillman and Platts (1993)	100%
Bonar et al. (1997)	25%
AFS Protocol (Peterson et al. 2000)	2-48%

The AFS Interim Protocol (Peterson et al. 2000) is based upon a combination of the previous techniques, allowing it to take the statistical power a step further. This protocol calculates the minimum sample size needed of a given habitat type to have a specified probability of detection, depending upon the sampling technique chosen by the surveyor. Probabilities are then added together to give a total probability of detection in a specific sampling frame. In this protocol, night snorkeling, day snorkeling, and electrofishing can be used in combination, although each is assigned a different probability of detection given specific conditions (Figure 3b).

Figure 3b. Sampling efficiencies of different methods outlined in the AFS Protocol

MAXIMUM AND AVERAGE SAMPLING EFFICIENCIES FOR BULL TROUT SURVEY

Technique	Maximum	Average*
3-pass Electrofishing	53%	34%
Single-pass Electrofishing	31%	19%
Nighttime Snorkeling	40%	26%
Daytime Snorkeling (>9°C)	22%	11%

*Averages are across all habitat types
Taken from Peterson et al. (2000)

King County Sampling Strategy

In June 2000, R2 Resource Consultants, Inc. of Redmond, Washington produced a report for King County outlining a sampling strategy for bull trout and Dolly Varden within geographic King County (King County 2000). This report examined recent and historical documents with references to native char within King County, and identified priority watersheds that had not been surveyed formally for native char and met the habitat suitability criteria for bull trout as outlined by Bonar et al. (1997).

The sampling plan recommended by R2 Resource Consultants, consisted of a two-phase approach: sample the most likely candidates in the first year (Phase I), and then during subsequent years systematically sample the other watersheds in order of the likelihood of holding native char (Phase II). Phase I priority areas were determined to be likely areas of bull trout presence, but where native char had not been detected. These areas include the Snoqualmie River above Snoqualmie Falls, the upper Tolt River drainage, the upper Issaquah Creek drainage, the Green River drainage above Howard Hanson Reservoir, and tributaries of the White River within King County (Figure 4). Phase II areas include selected reaches of tributaries to the Cedar River, lower Green River, and Snoqualmie River. KC DNR biologists have identified tributaries of the Sammamish River that may be sampled during Phase II if they meet the basic habitat requirements for reproduction.

FIGURE 4

SAMPLING AREAS WITHIN KING COUNTY INITIALLY PROPOSED FOR BULL TROUT RECONNAISSANCE SURVEYS

KING COUNTY

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Implementation of Sampling in King County

Implementation did not begin until August 2000. This impinged upon sampling in terms of field time, since weather delays during the autumn months can severely reduce the number of field days. The first objective was to identify areas within the Snoqualmie Watershed that had suitable habitat characteristics for bull trout. Scientists with the Army Corps of Engineers (ACOE) and the USDA Forest Service (USFS) who had expertise in bull trout biology and experience sampling for fish in the Snoqualmie Basin area helped to identify potential bull trout habitat. The Washington Department of Fish and Wildlife (WDFW) provided fisheries stocking and creel census data indicating that native char were not present above Snoqualmie Falls, although brook trout (non-native char) were present. Consideration was given to anecdotal and historical references of fisherman catching "dollies" and one reference from 1906 described a fish caught in Calligan Lake as "looking like a Sunnapee trout," a non-native eastern char species that has similar appearance to native char of Washington (Rief 1906). Anecdotal reports are valuable sources of historical information on native fish distribution, and helped in delineation of search areas.

In the fall of 2000, King County fisheries biologists began implementation of the R2 approach by applying the AFS Interim Protocol. The goal of this sampling plan is to identify populations of self-reproducing native char in geographic King County. Sampling commenced in the upper Snoqualmie River Basin in late September, and was completed during the second week of December 2000.

The first step in this sampling plan was to decide on the sampling frame for Phase 1 2000 projects. We were able to prioritize our Phase I areas based upon available funding. The KC DNR's Snoqualmie Watershed Team deemed the upper Snoqualmie Watershed to be the highest priority for Water Resource Inventory Area (WRIA) 7 bull trout work. The Snoqualmie Watershed is located among three adjacent watersheds (the Skykomish, Cedar, and Gold Creek Watersheds) that have self-sustaining populations of native char. This makes the upper Snoqualmie Watershed an ideal candidate for a Phase 1 reconnaissance survey. This document summarizes the KC DNR's efforts in 2000 to identify habitat of native char in King County.

Objectives

The primary objective of the King County Bull Trout sampling plan in 2000 was to document the presence of stream-resident and fluvial bull trout in the mainstem and tributaries of the three forks of the Snoqualmie River. Secondary objectives were to assess the potential bull trout habitat in these areas, and to characterize the thermal regime of the upper basin. Table 1 outlines the approach taken by King County in the 2000 bull trout surveys, by summarizing the questions of interest and the approach taken to answer these questions. In future sampling efforts, partnerships with other jurisdictions are necessary for additional surveys and collection of historical data.

Table 1. Summary of King County Approach

Management Questions	Sampling Approach
What is the current and historical distribution of native char within King County?	R2 Report; Historical data; KC Sampling; Partnerships
What is the temporal distribution of these species at these sites?	AFS Protocol implementation; Historical data; Partnerships
What life history strategies occur in King County?	KC Sampling; Historical Documents; Partnerships
Where are native char self-reproducing in King County?	KC Sampling; Historical Documents; Partnerships
What is the population structure of these fishes?	KC Sampling; Micro-satellite DNA analysis
What is the timing window for King County to implement projects in these areas?	KC Sampling; Historical Documents; USFWS Consultation
Is the habitat in the upper watersheds suitable to support bull trout?	KC Sampling; Historical Documents; Partnerships
How do these fishes use the marine environment?	KC Sampling; Historical Data; Partnerships
Information Sources: **US ACOE, USFS, USFWS, WDFW, Seattle City Light, Tacoma Public Utilities, Plum Creek, Weyerhaeuser, etc.**	

METHODS

The AFS Interim Sampling Protocol was followed in the upper three forks of the Snoqualmie River Basin to assess the likelihood of bull trout occurrence upstream of Snoqualmie Falls. The AFS Protocol is for determining the likelihood of "presence" by applying a conditional probability for detection, but does not conclusively determine "absence". The probability of detection (assuming presence) depends upon the habitat complexity, survey methods, and density of bull trout in the area of interest (Peterson et al. 2001).

Sampling Frame

The first step in this sampling program was to identify a sampling frame (area of study). The sampling frame for the Snoqualmie included the three major river basins above Snoqualmie Falls, the North, Middle, and South Forks of the Snoqualmie River (Figure 5). Stratification of the area for sampling was primarily based on water temperatures with areas that met basic requirements for bull trout presence (such as temperatures below 15°C), and potential-spawning areas (temperatures below 10°C) the highest priority (Bonar et al.1997). Areas that did not contain suitable habitat for spawning or rearing were not considered in this survey. In addition areas that did not meet survey site requirements in the AFS Interim Protocol were eliminated for survey (i.e. wetted widths greater than 5 meters, reaches with a gradient larger than 15%, etc.) as described by Peterson et al. (2001).

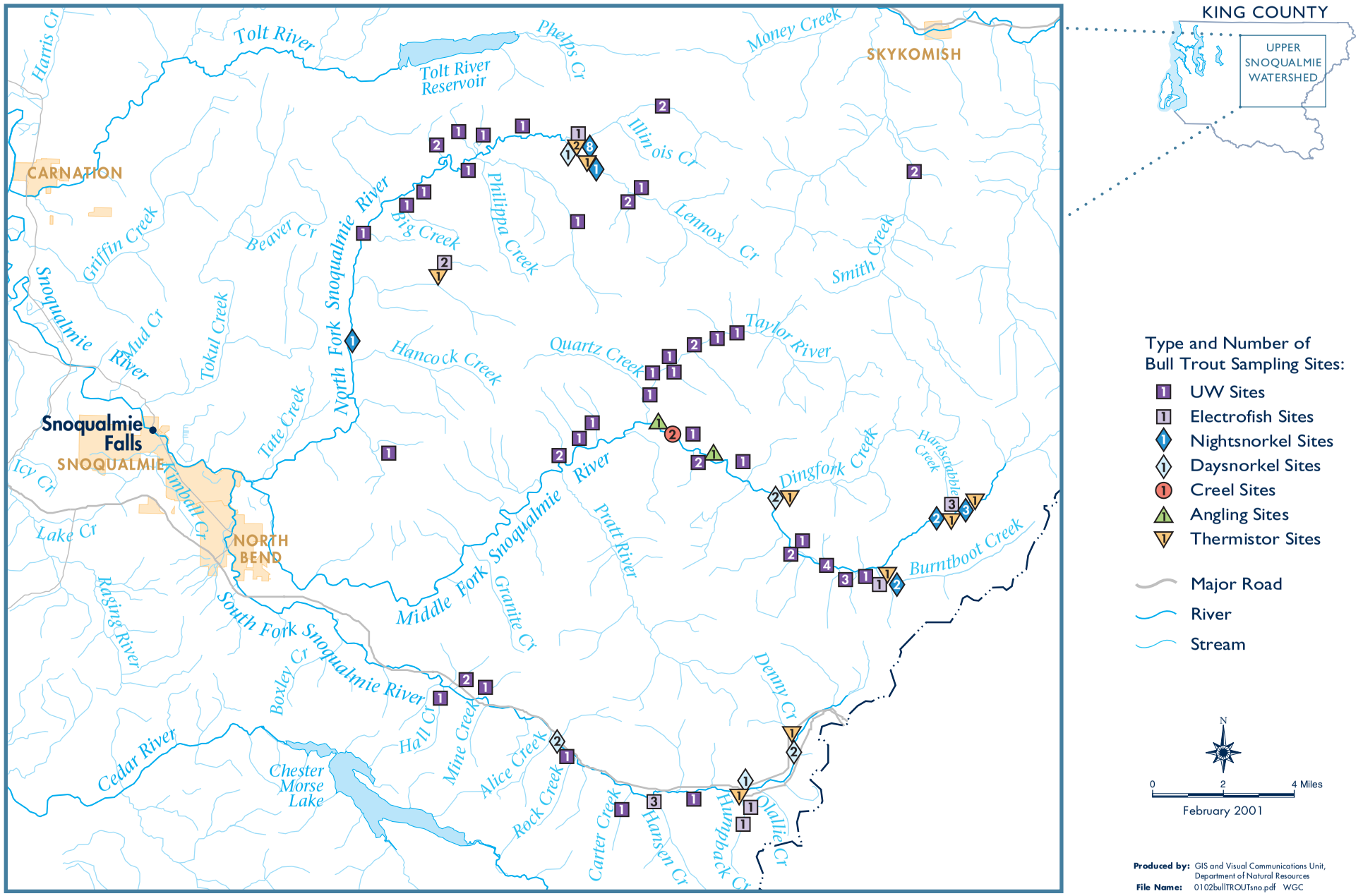


FIGURE 5

BULL TROUT SAMPLING SITES IN THE UPPER SNOQUALMIE WATERSHED

KING COUNTY

Legacy Data

Many areas within this sampling frame had been surveyed prior to this study, but native char had never been observed. Legacy data (historical data that is not first hand) from the North Bend Ranger District was examined. It appeared that the USFS had survey data for some of the sites of interest (especially sites on the North Fork). Areas where non-native char (brook trout) had been observed were surveyed in 2000 to determine if these fish were correctly identified, since areas that support brook trout can often support bull trout. Watson et al. (1997) used a statistically rigorous sampling strategy (Hillman and Platts' 1993 protocol) and identified bull trout populations in 6 streams that had been surveyed previously without detection of bull trout. This example points out that legacy data should not be the final word on whether or not bull trout are present in a particular location.

Site Selection

Consultation was sought from scientists who had worked in the upper Snoqualmie Basin, and reconnaissance efforts were prioritized based on their advice (Fred Goetz, ACOE, personal communication; Karen Bergeron, USFS North Bend Ranger District, personal communication). After characterizing the thermal regime of the basin and examining the data gathered in previous surveys, sites were stratified based upon the requirements outlined in the AFS Protocol. Existing Geographic Information System (GIS) data for the upper Snoqualmie River (listing physical features such as gradient and stream width) was identified and queried by King County staff. A query in ArcView™ identified 437 randomly selected survey sites that met the basic habitat characteristics necessary for implementation of the AFS Protocol in the upper watershed. After determining which areas were accessible (either due to property boundaries, or public access), 100 potential sites were identified. After field reconnaissance, 42 sample sites that met all of the criteria listed above were selected. Sampling sites included both disturbed and undisturbed areas, as described by Bonar et al. (1997). Additional criteria based upon Peterson et al. (2001) were considered in the selection of sampling sites:

- Is the maximum water temperature at these potential sites less than 16° C?
  If so, is the stream width larger than 2 m?
- Are over-winter temperatures less than 8° C?
- Is there an abundance of deep pools, with adequate cover, and low embededness?
- Do bull trout occupy similar areas in adjacent watersheds?
- What other factors need to be considered in site selection (e.g. public access)?
- Were these sites identified by other biologists as candidates for bull trout survey?

University of Washington Work

Josh Latterell, a Master's degree candidate from the University of Washington (UW) was interested in the extent of cutthroat trout distribution in the basin. For a portion of his thesis, he electrofished 64 sites in the upper Snoqualmie River Watershed during the summer and fall of 2000. The UW sites were identified to be within the King County sampling frame and GIS strata. A small portion of the data collected by Josh Latterell is included in this report.

Sample Size

The required sampling size was calculated from tables outlined in the draft AFS Interim Protocol (Peterson et al. 2000). Electrofishing and night snorkeling were chosen as primary sampling methods, which required a sample size of 55 sites within the sampling frame (using habitat values collected by the USFS North Bend Ranger District in the AFS Protocol). Night snorkel surveys were conducted only when the water temperature was less than 9°C, visibility was high, and large woody debris (LWD) density was low in an effort to maximize efficiency. These factors reduced our necessary sample size

from 55 to 52 sites to make an inference with 80% confidence, that bull trout were not present in this watershed. Multi-pass electrofishing required roughly the same number of survey sites as nighttime snorkel surveys (52), given similar habitat constraints. In all of these instances, the minimum survey length was chosen to be 50 meters, although in many surveys we increased the length due to hydraulic constraints such as falls, cascades, changes in gradient, etc. Appendix 1 is a table detailing how the AFS Protocol determines the necessary sample size based upon survey reach characteristics (Taken from Peterson et al. 2000).

It is important to remember that lack of detection does not necessarily eliminate bull trout from the sampling frame, but does indicate that the density of a potential bull trout population in this area is very low (less than the detection limits established in the AFS Protocol). This sampling protocol does not conclusively establish absence, but rather gives a confidence interval of 80% of their absence.

Reach Selection

Prior to sampling selected reaches, reconnaissance surveys were carried out in those selected portions of the watershed. Temperature, LWD presence, and pool depths were recorded throughout the survey reach. If the habitat requirements listed in the AFS Protocol for our sampling strategy were met, then the lengths of the reach were measured and the start and end points flagged. In addition, observations of the area immediately upstream were taken to see whether or not surveys should be conducted at several sites within this same geographic area. In many cases, additional surveys were carried out at these locations depending on available staff time and weather conditions.

Techniques

Snorkeling: Snorkel surveys were conducted in an upstream direction, using protocols described by Thurow (1994). In most instances, surveys were conducted at night to maximize the efficiency of the survey (Peterson et al. 2000; Goetz 1994). Survey reaches were between 50 and 100 meters in length, and encompassed at least three pool habitats (Peterson et al. 2000). In addition, survey reaches identified had at least one pool with a maximum depth greater than 0.75 m. Fish identification was to the species level. Personnel stationed out of the water were responsible for data collection and safety of swimmers in the water, as defined in the King County Snorkel Safety Plan (Alston 2000). All snorkel surveyors had been trained in fish identification prior to sampling. Two project biologists had completed US Fish and Wildlife Service Bull Trout Training prior to these surveys, and at least one of them participated in each of the 2000 bull trout surveys. Appendix 6 is a datasheet used for snorkel surveys conducted in 2000.

Electrofishing: Electrofishing surveys were conducted using battery-powered Smith Root (Vancouver, Washington) backpack electrofishers. Either single pass or multi-pass (three-pass) electrofishing was used, depending on the depletion efficiency. Settings were adjusted on the electrofisher to coincide with the recommended settings given the conductivity of sample reaches. Fork lengths were recorded to the nearest millimeter and fish were identified to the species level. Appendix 7 is a datasheet used for electrofishing data collected in 2000.

At the UW sampling sites, fish were anesthetized using clove oil. Josh Latterell's electrofishing protocol consisted of sampling upstream (in a single pass) until no fish were encountered, then proceeding another 400 m beyond that point. Surveys ceases where the streambed was dry for over 200 m of channel, or where the gradient exceeded 30% to the channel head. If there was any suspicion that fish persisted upstream of a barrier, sampling continued until no doubt remained.

Creel Census: When encountered, anglers were asked how many fish were caught, where they were caught, and what species were observed. The interview included questions about native and non-native char, and whether or not the individual had encountered any char species in any portion of the upper Snoqualmie River Basin.

Angling: Angling was conducted at two sites on the Middle Fork of the Snoqualmie. Spinning tackle was used, and spinners were the attractant chosen to capture salmonids in these reaches. The time interval for angling surveys was one hour.

Photos: Photos were taken at each sampling site using a Kodak DC-280 digital camera, and a waterproof Minolta APS camera (Weathermatic™).

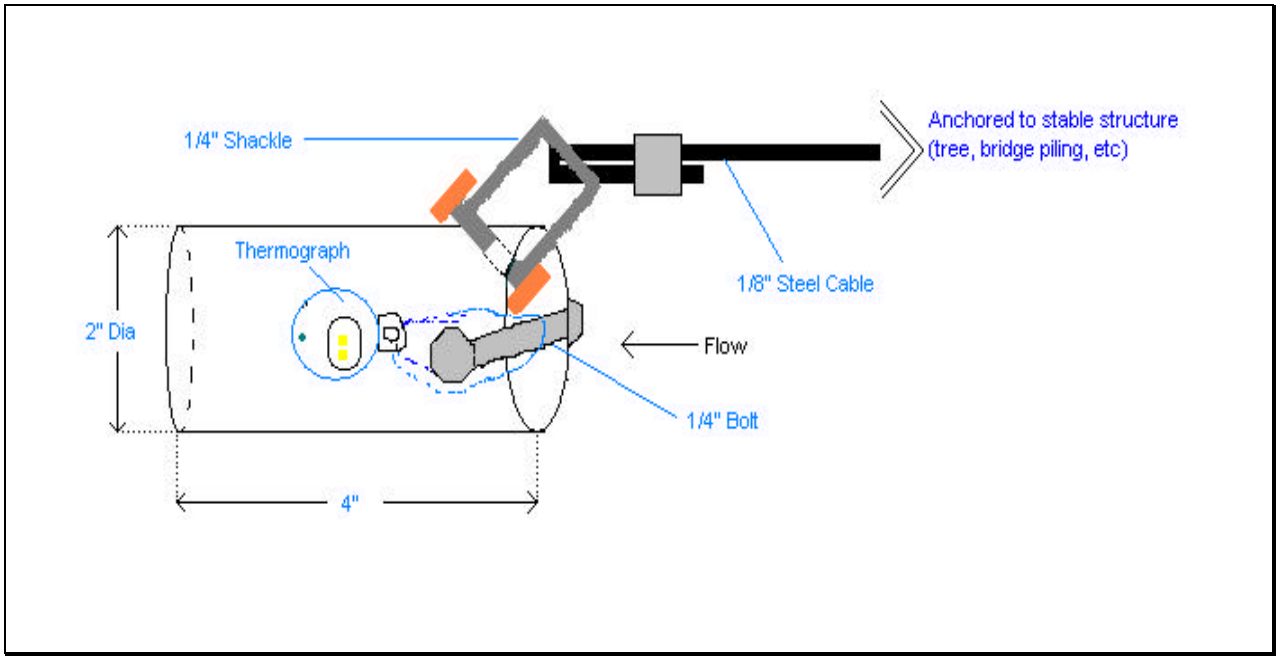
Maps: The USFS North Bend Ranger District provided field maps for surveys. Site location was attempted using GPS technology, but poor reception in the steep valleys forced its use to be abandoned throughout much of the watershed. In these instances sites were identified on a topographical map and then transferred to ArcView shape files for data management purposes.

Habitat Survey: Informal habitat surveys were conducted at each site. This was accomplished by first determining the length of a given sample reach, and then identifying at least three pools within each reach. Each pool was examined further to make certain that at least one pool had a maximum depth of at least 0.75 meters.

Temperature: Hand held alcohol-based thermometers were used to collect instantaneous temperature data at all potential sites in the basin. After pre-determining cold-water areas (less than 10°C) that also met habitat criteria for bull trout, thermographs were launched (Onset Tidbits™, Pocasset, MA) to assess the actual thermal regime of the area through continuous temperature recordings. These instruments were calibrated in the field using a laptop computer running BoxCar 4.0™ software. These data loggers collect information for an entire year. These data are downloaded annually for examination.

In order to protect these instruments from high-flow events and subsequent changes in the channel, housing capsules were constructed. These protective housings consist of two-inch diameter iron pipe, cut in four-inch lengths. These pipes were then perforated with three ¼" holes (two, directly across from each other, and the other ¼" from the aperture of the pipe). In the hole nearest the edge, a ¼ inch galvanized shackle was threaded through one end creating an attachment point for a 1/ 8 inch braided steel anchor cable. This cable was then fixed to a permanent location (such as a bridge footing, or large tree) outside of the wetted channel. A ¼" stainless steel bolt is threaded through the other two holes providing an attachment point for the thermograph using 1/8" stainless steel wire tied to this cross bolt. Water is allowed to flow through the iron pipe, parallel to the thermograph and data is recorded and stored in each Tidbit™. Temperature is recorded in degrees Celsius, and data is logged every two hours. Each thermograph has a site-specific number and its data are recorded and stored in BoxCar 4.0™. Figure 6 is a schematic of the thermograph housing and the Tidbit™ thermograph.

Figure 6. Schematic of thermograph housing



RESULTS OF SAMPLING EFFORT IN KING COUNTY 2000

In 2000, 95 sites in the upper Snoqualmie watershed were surveyed for the likelihood of bull trout presence. King County staff directly surveyed 43 of these sites, and UW researchers sampled another 52 sites. Summaries for each of the drainages are listed below.

Middle Fork of the Snoqualmie

After careful consideration, and advice from biologists at the USFS and US ACOE who had worked in the Snoqualmie Basin, it was decided that the Middle Fork of the Snoqualmie was the most likely area to support bull trout, and the first area to have access affected by winter snowstorms (Figure 7). The Middle Fork of the Snoqualmie was sampled upstream from the Taylor River confluence to the headwaters near Dutch Miller Gap. In addition to mainstem surveys, surveys were conducted in Hardscrabble, Burntboot, and Dingford creeks. The Middle Fork contains physical habitat that may be suitable for bull trout (abundant pools and woody debris complexes) but in sampling many of these areas, it appeared that high flow events and warm water temperatures severely limit the potential for native char to utilize these areas. After characterizing the basin, sites were identified that had the highest degree of probability for holding stream resident bull trout during autumn and early winter.

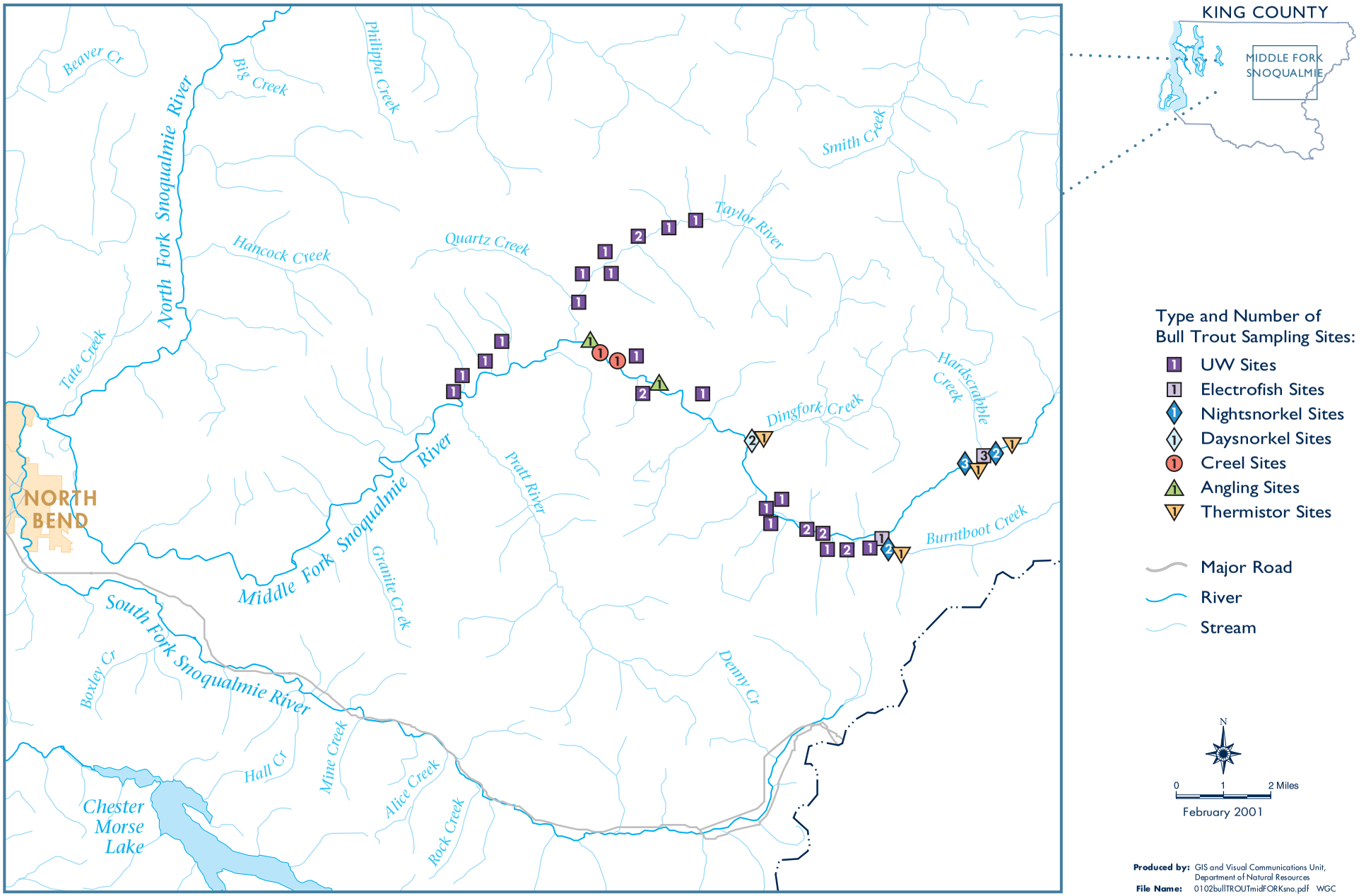


FIGURE 7

BULL TROUT SAMPLING SITES ALONG THE MIDDLE FORK SNOQUALMIE RIVER

KING COUNTY

Fisheries surveys began during the first week n October 2000. Normally, the recommended sampling window for bull trout is between June and the middle of September, but unfortunately this project was delayed until mid September, which increased the threat that winter storms would make surveys difficult. Surveys began in the headwater areas with the assumption that normal rain and snowstorms during the fall would make surveys impossible. The mainstem Middle Fork Snoqualmie (from the "end of the road" to the wilderness boundary) and Hardscrabble Creek were sampled for bull trout presence. This area has some excellent habitat, although significant winter flows make it difficult for the persistence of fall-spawning fish. Low densities of salmonids species were found in Hardscrabble Creek (.038 fish/m^2) and the mainstem Middle Fork (.045 fish/m^2). Hardscrabble Creek appears to be flashy, and the low density of resident rainbow and cutthroat trout suggest that this creek is not very productive. The mainstem Middle Fork is more productive than adjacent tributaries, however much of this area is devoid of complex cover. Cutthroat, rainbows, and their hybrids were present in the mainstem. Fish larger that 200 mm were not found in this segment. Hardscrabble Creek was sampled by electrofishing, and the mainstem Middle Fork was sampled by nighttime snorkel survey.

Burntboot Creek was the next site sampled. Burntboot is a tributary that drains the Alpine Lakes Wilderness area directly south of the mainstem Middle Fork. This tributary contains cold water (less than 8°C), and flows through pristine habitat. This tributary is very steep upstream of Goldmeyer Hotspring, possibly limiting the range for fluvial salmonids (with a grade greater than 15%). This watercourse was surveyed from its confluence with the Middle Fork of the Snoqualmie, to the falls at Goldmeyer Hotspring. Observed salmonid densities were .070 fish/m^2 for resident salmonids (rainbow and cutthroat trout). Tailed frogs and salamanders were abundant in this stream. Both nighttime snorkeling and electrofishing were used as sampling methods.

Dingford Creek is a steep tributary originating in the from the its falls to its confluence with the Middle Fork, and offered few areas that meet the requirements for a formal survey. Surveys began below the falls, and very low densities of salmonids (0.01 fish/m^2) were found in this stream. Unfortunately surveys were not conducted above the falls, due to logistical constraints. In previous surveys in that area, USFS personnel did not find any char (native or non-native) although both rainbow and cutthroat trout were present.

Below Dingford Creek, two mainstem sites were sampled using angling techniques. Thirteen salmonids were captured near river mile 65.0 (cutthroat and rainbow trout). In addition, other anglers were interviewed that spoke of catching brook trout in the Middle Fork, but not recently. There are many deep, clear pools in the lower river, but they are too large to apply the AFS Interim Protocol. In addition the temperature regime in the lower river is much too high to support bull trout spawning.

UW researchers sampled tributaries between Burntboot and the Taylor River. Salmonid species observed in the Pratt and Taylor Rivers were the same as those in the other portions of the watershed, and temperature data for these two areas eliminates successful bull trout spawning and incubation. These findings were consistent with the legacy data collected by the Mount Baker-Snoqualmie National Forest (Cascades Environmental Services, Inc. 1997). Table 2 contains the general survey data collected at Middle Fork Snoqualmie survey sites in 2000. Refer to Appendix 2 for additional survey data.

Table 2. Fisheries Survey Data from Middle Fork of the Snoqualmie River

Survey Technique	Survey Reaches	Observed Bull Trout	Other Salmonids	Temperature Range during survey (°C)
Electrofishing	4	0	Cutthroat, Rainbow Trout	8-12 degrees C
Nighttime Snorkeling	7	0	Cutthroat, Rainbow Trout	6-9 degrees C
Daytime Snorkeling	2	0	Cutthroat, Rainbow Trout	8-12 degrees C
Angling	2	0	Cutthroat, Rainbow Trout	12 Degrees C
Creel Surveys	2	0	Cutthroat, Rainbows and Brook Trout	12 Degrees C
UW Electrofishing Sites	29	0	Cutthroat, Rainbows and Brook Trout	8-15 degrees C
TOTALS	***46***	***0***		

North Fork of the Snoqualmie

Surveys in the North Fork of the Snoqualmie began on 30 October 2000 and continued through the month of November. Cold-water areas of the North Fork basin include the Lennox Creek sub-basin, the Calligan Lake sub-basin, and the Upper North Fork sub-basin upstream of its confluence with Lennox Creek (Figure 8). Several large pools in the lower North Fork Basin were also surveyed for bull trout although the thermal regime would make it unlikely for bull trout presence at these sites.

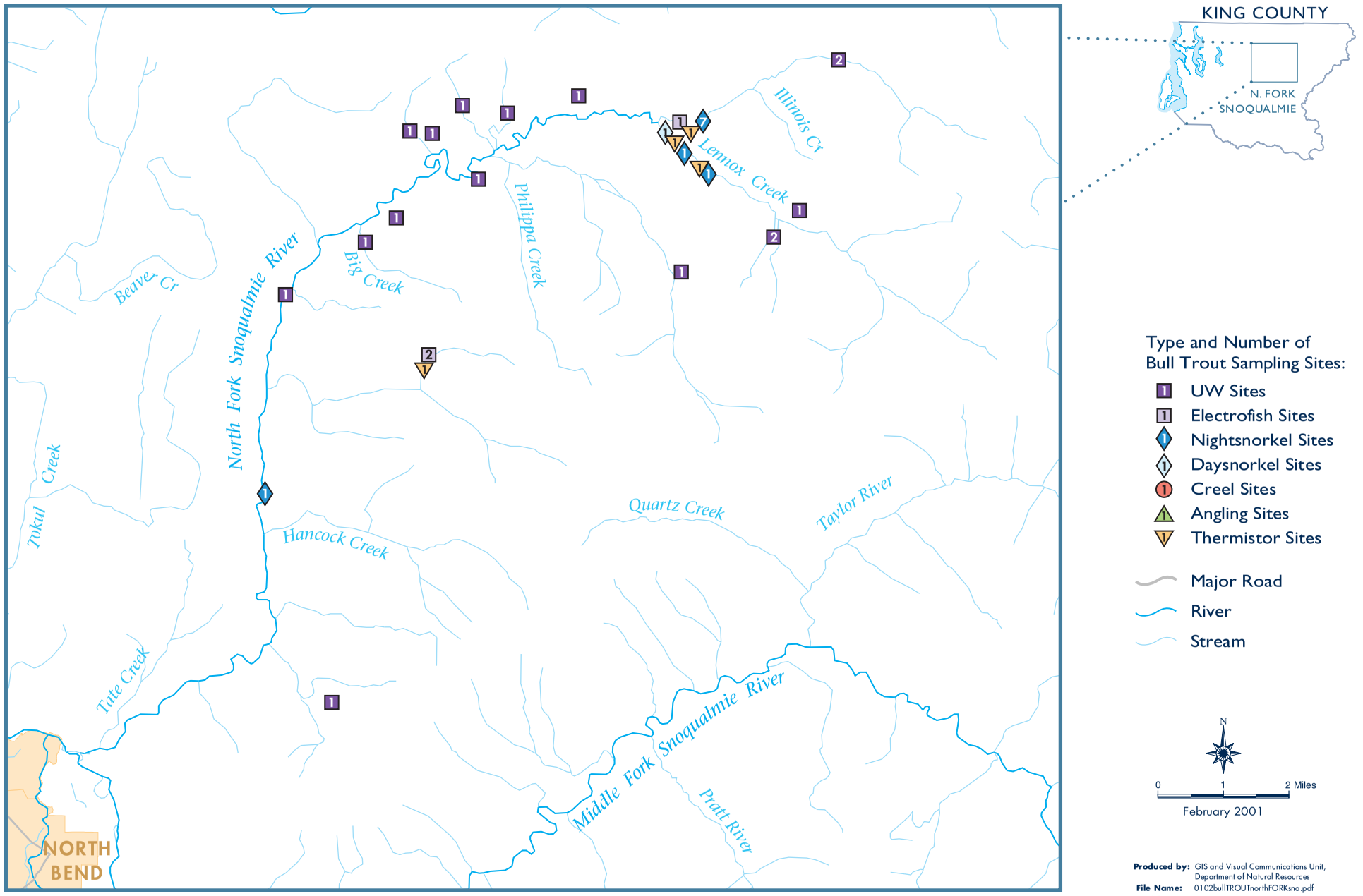


FIGURE 8

BULL TROUT SAMPLING SITES ALONG THE NORTH FORK SNOQUALMIE RIVER

KING COUNTY

Sites in the Upper North Fork Basin begin upstream of the mainstem North Fork's confluence with Lennox Creek, and the road bridge over the mainstem. This portion of the mainstem has heterogeneous habitat consisting of pools, riffles, runs, glides, cascades, and side channels. Many pools in this reach are formed by "key" pieces of large woody debris (LWD), primarily rootwads (Platts et al. 1983). High winter discharge events are present in this sub-basin as a result of forest practices, which severely limit the potential for bull trout persistence.

Survey methodologies for this sub-basin included using nighttime snorkeling (6 sites) and multi-pass electrofishing (1 site). One site chosen for electrofishing was also snorkeled at night to see if there was a difference between methods at detecting species in a given sampling reach. In this exercise, sculpin were encountered in electrofishing, but not in the snorkel survey. In contrast, more salmonids (8 rainbow trout and 4 brook trout) were detected in the snorkel survey than in the electrofishing survey. Both sets of data are reported in this report, but only the electrofishing data is included in the density estimate since it was the randomly selected method for sampling this site. The interesting note in this area was the observation of non-native char (brook trout). These fish were encountered only in nighttime snorkel surveys. Brook trout behave much like a bull trout, and spawn during the same time period. In many instances brook trout hybridize with bull trout (Markle 1992). The fish encountered were ripe with gametes, and appeared to be spawning in nearby riffle habitat. Brook trout detection suggested that these sites were in potential bull trout habitat in the basin, although no native char were detected.

The next portion of the watershed surveyed was the Lennox Creek sub-basin. Lennox Creek and its tributaries originate high in the watershed. The habitat quality in Lennox Creek includes some deep pools, small waterfalls, cascades, riffles, and glides. Lennox Creek lacks LWD, although it has an abundance of boulders that provide some of the functions normally associated with LWD. Three sites on Lennox Creek were surveyed using daytime snorkeling (1 site) and nighttime snorkeling (2 sites). Lennox Creek holds very low densities of resident rainbow and cutthroat trout (0.028 fish/m^2).

Calligan Lake is a large lake that drains into the North Fork of the Snoqualmie River. This lake supports a recreational fishery of stocked rainbow and cutthroat trout. A creel survey in 1906 reports a strange fish present in Calligan Lake (Rief 1906), described as appearing similar to the Sunnapee Trout. The Sunnapee Trout is a char that is native to Northeast North America. This fish has a dark body with light colored spots, much like a bull trout or Dolly Varden. After further examination of the tributaries of Calligan Lake, one tributary was identified that could potentially support reproducing bull trout.

This tributary has an average wetted width less than three meters, and contains few pools that would help in supporting a resident bull trout population. The flow characteristics are dominated by snow, which increases the potential for bull trout incubation throughout the winter. The water temperature in this stream was less than 8°C during sampling events. Since this stream is so narrow, multi-pass electrofishing was chosen as the best sampling method. Two sites were surveyed in this watercourse but did not contain any char. The density of salmonids in this watercourse was 0.014 fish/m^2, which only included cutthroat trout species. Several Pacific Giant Salamanders were enumerated at these two sampling sites.

Several large pools were surveyed in the mainstem below the Calligan Lake turnoff. These sites were sampled using nighttime snorkel surveys, with multiple observers. The average residual pool depth of these habitats was greater than six feet. Salmonids were detected in low densities (.010 fish/m^2), and a few sculpin were observed in each pool. Expected densities of salmonids were much higher than detected, given the depth and the number of large boulders providing complex cover for these fishes. Although not a part of this study, primary productivity appears to be a limiting factor for salmonids in the North Fork Snoqualmie River. Table 4 contains the general survey data collected at North Fork of the Snoqualmie River survey sites in 2000. Refer to Appendix 3 for additional survey data.

Table 3. North Fork of the Snoqualmie Fisheries Data

Survey Technique	Survey Reaches	Observed Bull Trout	Other Salmonids	Temperature Range during survey (°C)
Electrofishing	3	0	Cutthroat, Rainbow Trout	6-10
Nighttime Snorkeling	10	0	Cutthroat, Rainbow Trout, Brook Trout	7.8-10
Daytime Snorkeling	1	0	Cutthroat, Rainbow Trout	10
Angling	0	0		
Creel Surveys	0	0		
UW Electrofishing Sites	16	0	Cutthroat, Rainbow Trout, Brook Trout	Not Recorded
TOTALS	30	0		

South Fork of the Snoqualmie

Sampling commenced on December 5, 2000 in the South Fork of the Snoqualmie River. Reconnaissance efforts identified potential bull trout habitat to include Denny Creek, Humpback Creek, Hansen Creek, and the mainstem upstream of the Tinkham Campground (Figure 9). Electrofishing and daytime snorkeling were decided to be the sampling techniques (based on the safety constraints).

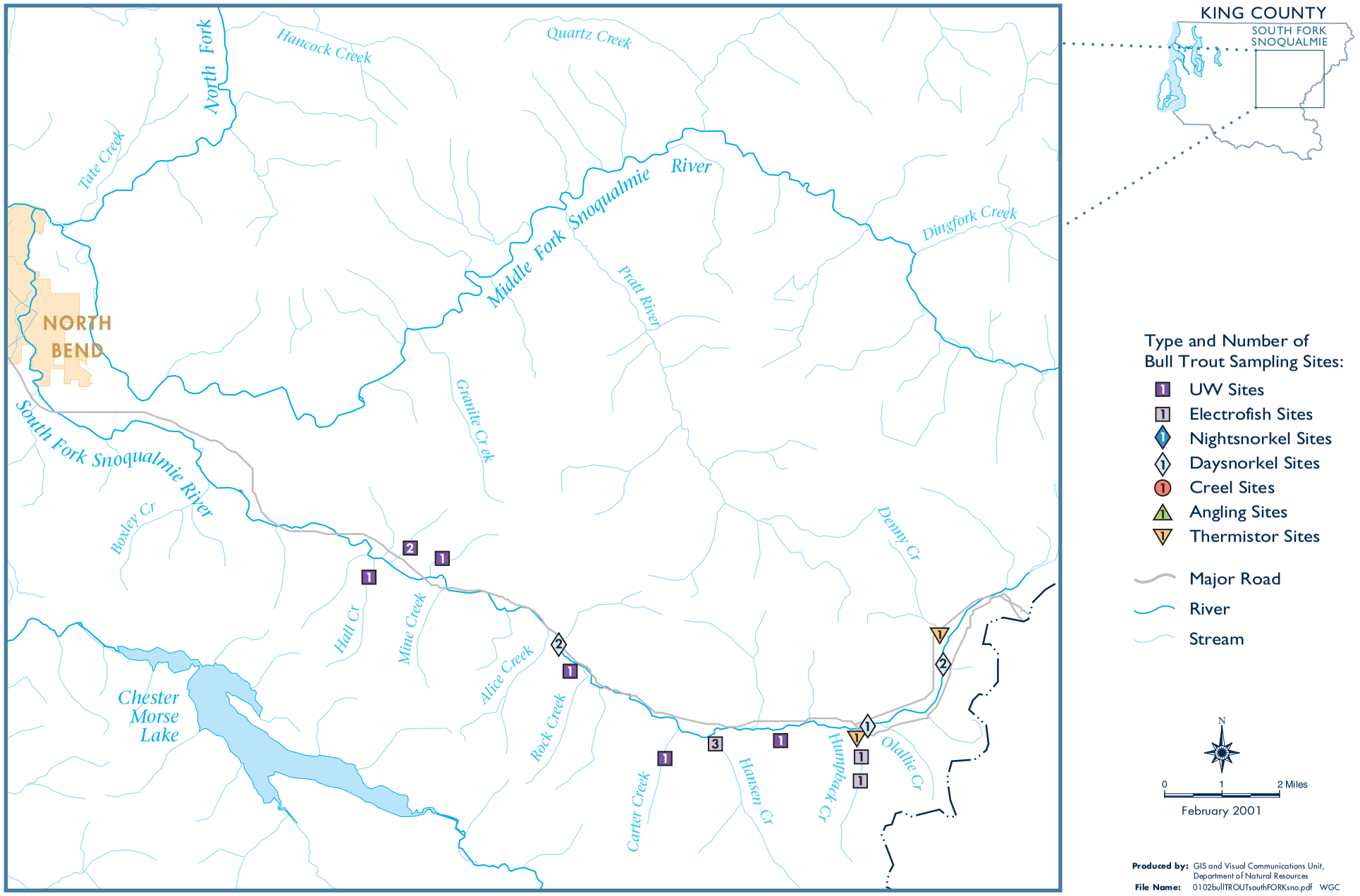


FIGURE 9

BULL TROUT SAMPLING SITES ALONG THE SOUTH FORK SNOQUALMIE RIVER

KING COUNTY

Denny Creek has populations of rainbow, cutthroat, and brook trout (Jones 1999). Historical accounts mention "Dollies", but daytime snorkeling exercises did not detect any char (Jones 1999). The habitat in Denny Creek includes complex woody debris jams, pools, runs and riffles. The thermal regime could support all life cycles of bull trout, since the hydrology of the system is snow dominated. The densities of salmonids detected in Denny Creek were close to 0.024 fish/m^2.

Humpback Creek drains in a northerly direction from Annette Lake to its confluence with the South Fork of the Snoqualmie near the parking lot at the Annette Lake trailhead. Humpback Creek holds small resident populations of rainbow and cutthroat trout in densities of 0.014 fish/m^2. Humpback Creek was sampled using electrofishing equipment at three sites.

Hansen Creek is another tributary of the mainstem South Fork of the Snoqualmie that supports a small population of resident salmonids including brook trout, cutthroat, and rainbow trout. Salmonid density in Hansen Creek is around 0.031 fish/m^2. This watercourse drains in a northerly direction to its confluence with the South Fork Snoqualmie of the River.

The mainstem South Fork Snoqualmie River near the Tinkham Campground is located along the I-90 corridor and is dominated by pool and riffle habitat. Although the channel is somewhat confined, it holds the highest density of resident salmonids of any reaches surveyed in this drainage. Daytime snorkel surveys found salmonid densities in this portion of the mainstem to be 0.04 fish/m^2. Resident fishes include cutthroat and rainbow trout.

Sampling efforts in the South Fork Snoqualmie were limited by weather. Snowstorms in the drainage prevented access to many sites in the Denny Creek sub-basin, inhibiting this sampling program. Nighttime snorkel surveys were not conducted in the South Fork for safety reasons, warranting further sampling in this portion of the watershed during the summer of 2001. Table 5 contains the general survey data collected at South Fork Snoqualmie survey sites in 2000. Refer to Appendix 4 for additional survey data.

Table 4. South Fork Fisheries data.

Survey Technique	Survey Reaches	Observed Bull Trout	Other Salmonids	Temperature Range during survey (°C)
Electrofishing	6	0	Cutthroat, Rainbow Trout, Brook Trout	9-10
Nighttime Snorkeling*	0	0		
Daytime Snorkeling	5	0	Cutthroat, Rainbow Trout	9-12
Angling	0	0		
Creel Surveys	1	1*	Cutthroat, Rainbow Trout, Brook Trout	
UW Electrofishing Sites	7	0	Cutthroat, Rainbow Trout, Brook Trout	Not Recorded
TOTALS	19	1**		

*No nighttime snorkel surveys were done in 2000, but 2001 nighttime snorkel surveys are proposed.

**Angler surveyed said that he has caught "Dollies" in Denny Creek, and mentioned catching brook trout in the Middle Fork, indicating that he can differentiate between the two.

Results of Reconnaissance Survey in Snoqualmie

In addition to fisheries sampling, steps were taken to gather important temperature data throughout the upper Snoqualmie Watershed in the fall of 2000. Thermographs were deployed in ten locations (see Figure 5) in the watershed to get an idea of the thermal regime of the basin during the winter, which should be indicative of bull trout incubation potential. In 2001, these data will be downloaded and efforts will be made to determine if thermal constraints for incubating bull trout eggs are too great for successful spawning and rearing in the areas sampled in 2000 (McPhail and Baxter 1996; Goetz 1989). If temperatures do not preclude spawning and incubation, temperature data will be used to prioritize additional survey areas.

Reconnaissance in the Green River and Issaquah Basin

In 2000, KC DNR surveyed sites in the Issaquah Basin and upper Green River Watershed as reconnaissance for 2001 bull trout surveys (Figure 10). Selected reaches of Carey Creek (in the Issaquah Basin) where native char have been observed were identified and thermographs were placed at these sites to gather appropriate baseline temperature data before a formal survey would commence in 2001.

In the upper Green River Watershed, contact was made with biologists at Tacoma Public Utilities (TPU) and Plum Creek who are interested in collaboration on bull trout surveys above Howard Hanson Reservoir in 2001. In 2000, King County staff deployed thermographs at these sites to assess over-winter temperatures in these watercourses and determine if a population of reproducing bull trout could inhabit these areas. Tacoma has assumed presence of bull trout in their Habitat Conservation Plan (HCP) planning effort, although previous bull trout surveys conducted by Plum Creek have not yielded any native char. KC DNR will be working directly with both TPU and Plum Creek to determine presence/absence in the upper watershed in 2001. This is a great opportunity for KC DNR personnel to collaborate with biologists at TPU and Plum Creek.

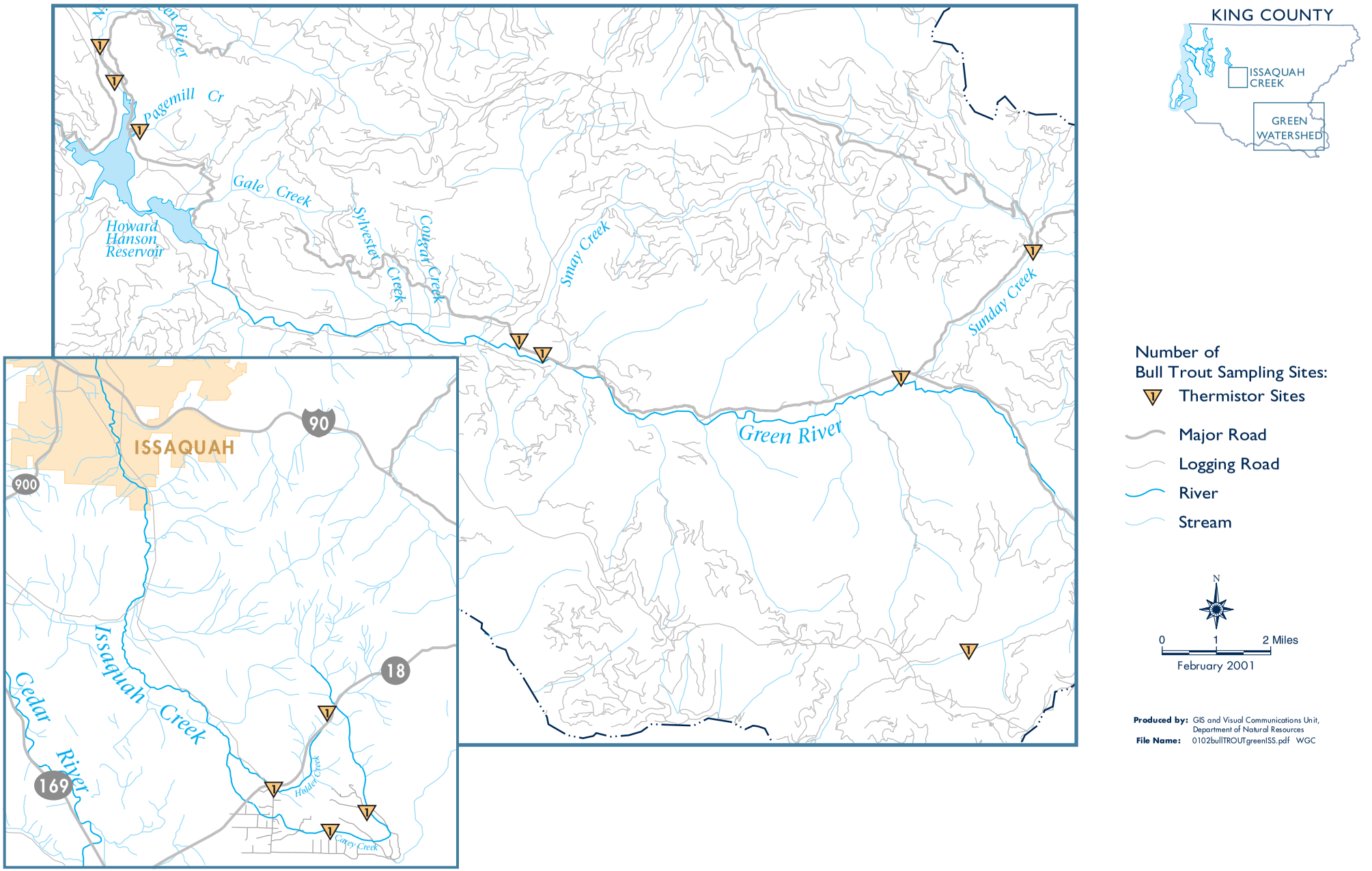


FIGURE 10

BULL TROUT SAMPLING SITES IN THE UPPER GREEN RIVER WATERSHED AND ALONG ISSAQUAH CREEK

KING COUNTY

Proposed 2001 and 2002 Bull Trout Surveys

Surveys conducted in 2000 were only the first step of Phase I as prescribed in the R2 Report (King County 2000). Phase I implementation will continue into 2002. Additional work is needed to fill in data gaps for other watersheds in King County. The following paragraphs identify proposed 2001 and 2002 survey sites in order of their priority. Figure 11 highlights the portions of King County that are proposed to be surveyed in 2001 and 2002 as part of the Phase I bull trout sampling program.

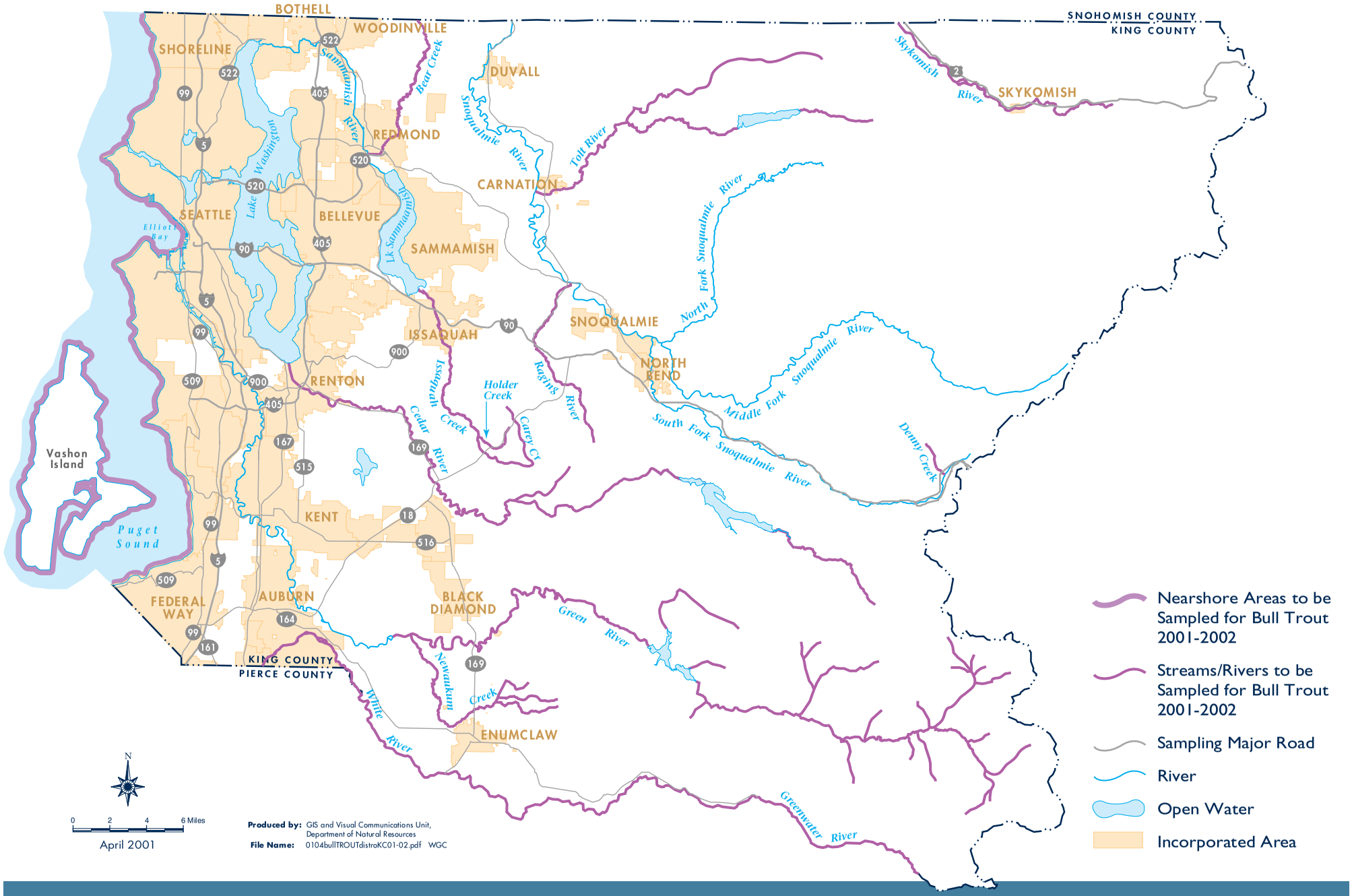


FIGURE 11

2001-2002 PHASE 1 BULL TROUT SAMPLE SITES

KING COUNTY

South Fork of the Snoqualmie River

In the fall of 2000, sampling efforts in the South Fork Snoqualmie were limited by bad weather, mainly snowstorms that prevented access to many sites in the Denny Creek sub-basin. Nighttime snorkel surveys were not conducted in the South Fork due to safety (risk of hypothermia), warranting further sampling in this portion of the watershed during the summer, ore early fall of 2001. To be consistent with AFS protocols, we recommend at least ten nighttime snorkel surveys in the drainage, at randomly selected sites in each of the four major sub-basins sampled in December of 2000, with 6 of these sties in the Denny Creek sub-basin. Once these reaches are surveyed, King County bull trout surveys upstream of Snoqualmie Falls will be complete.

A proposal for this work has been submitted to the Watershed Coordination Unit in King County's Water and Land Resources Division.

Nearshore Environment

Native char of Washington (Dolly Varden and bull trout) can be amphidromous salmonids; migrating through a saltwater environment for foraging purposes, and not necessarily reproduction (Meehan and Bjornn 1991). Historically, native char have been captured in the nearshore environment along King County beaches. Until recently, it was assumed that these fish were Dolly Varden. In 2000 sixteen fish were captured in the King County nearshore environment. One of the samples is from the mainstem of the Green River near the Newaukum Creek mouth (collected by the Muckelshoot Indian Tribe [MIT] Fisheries Department), eight samples are from the Duwamish estuary (collected by consultants working for the Port of Seattle), and seven samples from Shilshole Bay (collected by the MIT Fisheries Department). Tissues (approximately 0.5 cm^2 of caudal fin) from these fish were stored in 95% ethanol. Three samples were subsequently sent to the University of Montana Wild Trout and Salmon Genetics Laboratory in Missoula, Montana who determined that all three were bull trout. Funding is needed to analyze the other twelve samples from 2000 and any future samples collected in 2001and 2002.

Because of char's relatively frequent and sustained presence in the nearshore environment, and the high likelihood of commingling of char stocks from a variety of watersheds in the nearshore environment, King County should sample the nearshore marine waters in 2001and 2002 to improve our understanding of their population characteristics, habitat utilization, diet, and migratory pathways.

A proposal for the genetic sampling portion of this work has been submitted to the Watershed Coordination Unit in King County's Water and Land Resources Division.

Green River

Despite sampling by Plum Creek fisheries biologists in the 1990's, native char have not been found in the Green River or its tributaries above Howard Hanson Dam (Watson et al. 1997). In 2000, King County placed eight thermographs above Howard Hanson Reservoir. The intent of this exercise was to identify areas in the upper Green River Watershed capable of supporting bull trout spawning and rearing, and then apply the AFS Protocol in these streams. Once temperature data are retrieved from the dataloggers, we can identify potential bull trout habitat in the upper watershed and establish a sampling program for detection of native char.

Bull trout have been found near the mouth of Newaukum Creek on several occasions by the MIT. These sightings pose an interesting question as to whether or not there is a self-sustaining population of migratory or stream resident native char (either bull trout or Dolly Varden) within the Green River Basin. Implementation of the King County sampling program in selected areas of the Green River will be beneficial in determining whether or not these fish collected in the Green are opportunistic foragers from another system or if natural reproduction of native char occurs in this basin.

Issaquah Creek

A single sighting of char in Carey creek of the upper Issaquah Creek Basin suggests that native char do occur at least on occasion in this watershed. In 2000, thermographs were placed in Issaquah, Carey, and Holder creeks to establish whether fall temperatures were sufficiently cold to support success char spawning. This portion of WRIA 8 should also be surveyed in order to formally establish if this observations an isolated occurrence or if there is indeed a naturally reproducing population of native char in Issaquah Creek, or at the least regular use by foraging sub-adult or adult char. Formal surveys using the AFS Protocol conducted in 2001 and 2002 will be able to gather necessary data to make this determination.

Cedar River

The Cedar River Basin in and above Lake Chester Morse sustains a known population of adfluvial and stream-resident bull trout. Seattle City Light manages this portion of the Basin, and has conducted several studies on habitat use and spawning site selection in the upper Cedar River Watershed (Dwayne Paige, personal communication). Although much is known about this population, little genetic characterization has been done. By comparing the genetic structure of these fish with other fish captured in King County we will be able to determine if this population is the source of these native char found in other areas. Seattle City Light has expressed interest in a collaborative effort with KC DNR to better understand this population. A minimal sampling effort to collect fin tissue from this population would provide useful data for the KC DNR's bull trout sampling program.

Occasional sightings of bull trout in the lower Cedar River (below Landsburg) raise some interesting questions concerning bull trout distribution in this system. Some of the better bull trout habitats in WRIA 8 are in the lower Cedar River Basin (below Landsburg) including Rock, Peterson, Taylor, and Walsh Lake creeks, and the mainstem Cedar River itself. These streams should be surveyed for native char based on their potential to support these fishes. Surveys in 2001 and 2002 will provide a better idea of whether or not self-sustaining native char populations occur downstream of Landsburg in Cedar River Basin.

Tolt River

Several sightings of adult char have occurred in the Tolt River and the mainstem Snoqualmie River near the confluence with the Tolt (Figure 2). These sightings suggest that native char species may use the Tolt for foraging purposes and perhaps spawning. Further investigation is warranted in this basin to make this determination.

South Fork Skykomish

Since 1958, WDFW has annually transported approximately 40 adult native char above Sunset Falls on the South Fork of the Skykomish River (WDFW 1999). Sunset Falls is a natural barrier to anadromous fish and it is presumed that prior to the transport program, char did not exist above the falls. Further, it is presumed that these fish spawn primarily in the East Fork of the Foss River although observations of spawning char have occurred in Salmon Creek as well. In any event, little is known about this self-sustaining population of native char, and genetic analysis of this population will be critical to understand how presumably pioneering fish have adapted to a new environment. Further investigation of the extent of spawning in this basin may provide clues to how these fish can adapt to less than optimum thermal regimes, and may help identify undiscovered populations in other portions of this watershed. Surveys in 2001 and 2002 may also provide insight that can be applied to other pioneering populations that may exist in Issaquah Creek and the lower Green River for example.

A proposal for this work will be finalized during 2001 for surveys to begin during the summer of 2002.

White River and Greenwater Tributaries

The White River was connected to the Green River until a permanent barrier was constructed in 1907, diverting the water in the White River to the Puyallup River. Prior to this construction, it is presumed that bull trout were able to migrate freely between these systems. In 1993, nine native char were captured between River Mile 43 and 53 on the mainstem White, and four more were captured in the West Fork. These fish ranged between 99 and 300 millimeters in length, indicating that spawning was occurring in this watershed. In recent years, native char have been captured annually at the Mud Mountain trap and haul facility on the White River. The White River likely supported a strong population of native char as recently as 1953 when 693 fish were trapped in fish screens throughout the basin (Rees and Dunston 1953). Proposed efforts in 2001 and 2002 will help to identify the location and extent of spawning char in tributaries of the White River. This information will be important to better protect existing critical habitat in this portion of King County, and prioritize any efforts of restoration in WRIA 10. Genetic characterization of these fishes may provide insight to the origin of the fish sampled in the lower Green River and the mouth of Newaukum Creek.

A proposal for this work will be finalized during 2001 for surveys to begin during the summer of 2002.

Big Bear Creek Basin

Selected watercourses in the Bear Creek Basin have been identified as potential bull trout habitat. These areas include selected reaches of Cottage Lake Creek, Big Bear Creek, and Cold Creek. These areas have cold water, abundant prey species, and adequate spawning gravel for native char to persist. Surveys in 2001 will help to determine whether or not native char utilize these habitats.

CONCLUSIONS AND RECOMMENDATIONS

Every year, suitable bull trout habitat is degraded with poor land-use practices, which makes it even more difficult to understand population characteristics of bull trout (Ratliff and Howell 1992; Henjum et al. 1994). In King County, fragmentation of suitable habitats and populations appear to be the most serious threats to bull trout persistence, since interactions with exotic species are infrequent (Rieman et al. 1997). As these habitats are isolated, the risks of local and regional extinction are increased (Rieman et al. 1997; Rieman and McIntyre 1995). The goals of this sampling program are to get a better understanding of bull trout and elucidate populations of reproducing bull trout within geographic King County. Surveys conducted during 2000 were successful in increasing our understanding of the Snoqualmie River upstream of Snoqualmie Falls.

KC DNR bull trout surveys conducted in 2000 were targeted at determining presence/absence of bull trout in the upper Snoqualmie Watershed, and delineating potential bull trout habitat in geographic King County. Bull trout were not found upstream of Snoqualmie Falls in 2000 surveys conducted by King County staff. Although native char are found in adjacent watersheds and below Snoqualmie Falls, it appears that a remnant population does not exist upstream of the falls. This finding suggests that projects occurring upstream of Snoqualmie Falls do not need to consider bull trout presence in permitting requirements.

Temperature data collected in the spring of 2001 may identify potential areas for bull trout occurrence, and will help verify absence in areas that do not meet the obligate temperature requirements of incubating bull trout eggs. It is important to understand bull trout and their habitats to protect these fish from extinction risk (Baxter and McPhail 1997).

Under the ESA, King County is responsible for protection of listed species that reside within King County jurisdiction. In order to comply with federal and state recovery efforts (and to design local conservation programs), it is imperative that we know where and when bull trout are found in King County jurisdiction. All departments in King County that deal with development, transportation, and natural resources need this information.

At a local level, the King County Comprehensive Plan requires that species of federal, state and local concern are protected - and their habitats designated as critical areas. While bull trout may not be specifically listed in the plan, any species that is federally listed would be included under this protection. Federal protections of bull trout habitat, including future designation of critical habitat by USFWS, would impact development patterns, resource extraction, and other land uses in King County. By evaluating current bull trout habitats, King County is taking a proactive position in its planning efforts and able to shape County practices to protect bull trout.

On the project level, any small-scale project (i.e. a routine monitoring component of a Capital Improvement Project or an installation of a culvert or a shortplat for development) could be impacted by bull trout presence. Currently, King County is required to permit for these projects under the assumption that bull trout are present "erring on the side of the species" as directed in the ESA. By understanding the spatial and temporal distribution of bull trout in King County waters, the permitting and project design element of our routine work could be made easier. King County personnel currently perform biological assessments, apply for Section 10a1A permits, and conduct Section 7 consultations in areas where bull trout are *assumed* to be present by USFWS. A systematic sampling program will allow an understanding of this assumption and could save a considerable amount of resources. At the same time, King County is providing an excellent example for other jurisdictions working under the ESA, by cooperating with USFWS and taking a proactive stance in evaluating the status of these species in King County waters.

ACKNOWLEDGEMENTS

A number of individuals at King County were instrumental in completing bull trout surveys in 2000, including Karin Osterhaug, Abel Eckhardt, Jim Mattila, and Rob Blomquist of the King County Department of Natural Resources. We are grateful to Josh Latterell at the University of Washington for providing additional survey information to complement this study. We appreciate the assistance of Karen Bergeron of the Mount Baker-Snoqualmie National Forest, and Fred Goetz of the U.S. Army Corps of Engineers for their help prioritizing areas for surveys and information on prior studies in the Snoqualmie Watershed. Without programmatic assistance from Kate O'Laughlin, Bob Swartz, Megan Smith, and David St. John of the King County Department of Natural Resources, these surveys could not have taken place.

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APPENDIX 1 Night snorkeling sampling efficiencies taken from the AFS Protocol (Peterson et al. 2000).

Habitat-specific efficiencies for single-pass nighttime snorkel surveys and number of samples required to detect bull trout with 80% and 95% confidence in 50 and 100m long sampling units.

			50 m sampling units			100m sampling units		
				Number of samples for desired power			Number of samples for desired power	
Visibility	*Gradient*	Estimated sampling efficiency	Single sample prob. of detection	80%	95%	Single sample prob. of detection	80%	95%
low	low	14%	0.046	34	64	0.055	28	53
low	high	22%	0.066	24	44	0.078	20	37
high	low	28%	0.081	19	35	0.095	16	30
high	high	40%	0.105	15	27	0.120	13	23

Visibility classes:

low- visibility less than or equal to 50% of the mean channel width

high- visibility greater than 50% of the mean channel width

Gradient classes:

low- less than or equal to 4.5%

high- greater than 4.5%

APPENDIX 2

Additional Survey Data from the Middle Fork of the Snoqualmie River sampling in 2000

Segment Name	KC Survey Reaches	Survey Area m^2	Salmonid Density Fish/m^2	Other Species
Mainstem near RM 65	1	500	.026	
Taylor River	1	300	.010	
Dingford Creek	2	400	.010	
Burntboot Creek	3	787.5	.070	Sculpin, Pacific Giant Salamander, Tailed Frogs
Hardscrabble Creek	3	337.5	.039	Sculpin, Pacific Giant Salamander
Wilderness Areas	5	1260	.045	Sculpin, Pacific Giant Salamander

APPENDIX 3

Additional Survey Data from North Fork of the Snoqualmie River sampling in 2000

Segment Name	KC Survey Reaches	Survey Area m^2	Salmonid Density Fish/m^2	Other Species
Weyerhaeuser Property (large pools)	1	2000	.019	Sculpin
Lennox Creek	3	800	.028	
Upper Mainstem	7	1160	.046	Sculpin, Pacific Giant Salamander
Calligan Lake Northern Tributary	2	350	.014	Sculpin, Pacific Giant Salamander

APPENDIX 4

Additional Survey Data from South Fork of the Snoqualmie River sampling in 2000

Segment Name	KC Survey Reaches	Survey Area m^2	Salmonid Density Fish/m^2	Other Species
Tinkham Campground	2	720	.040	None
Hansen Creek	3	350	.031	None
Humpback Creek	4	900	.014	None
Denny Creek	2	500	.024	None

APPENDIX 5

Electrofishing Survey Datasheet

ELECTROFISH DATA FORM

UNIT # DATE SHOCKER WAVE, VOLTAGE, FREQ:

STREAM Start Finish

BASIN Time:

Temp:

CREW INITIALS:

COMMENTS:

LENGTH CLASS (mm)	CATCH BY PASS AND SPECIES Bt=bull trout; Ct=cutthroat; Rb=rainbow/steelhead; Bk=brook trout; Ck=chinook; Co=coho;									
	PASS 1		PASS 2		PASS 3		PASS 4		PASS 5	
	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked
30-39										
40-49										
50-59										
60-69										
70-79										
80-89										
90-99										
100-109										
110-119										
120-129										
130-139										
140-149										
150-159										
160-169										
170-179										
180-189										
190-199										
200-209										
210-219										
220-229										
230-239										
240-249										
250-259										
260-269										
270-279										
280-289										
290-299										
300-309										
310-319										
320-329										
330-339										
340-349										
350-359										
360-369										
370-379										
380-389										
390-399										
400-449										
450-499										
>500										
TOTAL:										
ASSOCIATED SPECIES: Present (+); Absent (-); Juvenile (J), Adult (A)										
Mt. Whitefish										
Sucker										
Sculpin										
Squawfish										
Tailed Frog										
Spotted Frog										
Western Toad										
Other?										

APPENDIX 6

Snorkel Survey Data Sheet

SNORKEL DATA FORM

UNIT # DATE
STREAM DIVERS INITIALS:
BASIN VISIBILITY(m): / /
BANK TO BANK VISIBILITY? Yes or No
TIME SINCE MARKING:
COMMENTS

SPECIES BY SIZE CLASS (mm)	DAY COUNT Time: Temp: start				NIGHT COUNT Time: Temp: start		finish	
	Diver___		Diver___		Diver___		Diver___	
BULL TROUT	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	Marked
YOY								
<100								
100-199								
200-299								
300-399								
>400								
TOTAL								
RBW TROUT								
YOY								
<100								
100-199								
200-299								
>300								
TOTAL								
OTHER: Ct=cutthroat Bk=brook Ck=chinook Co=coho								
YOY								
<100								
100-199								
200-299								
>300								
TOTAL								
PRESENCE(+)/ ABSENCE JUVENILLE(j) ADULT(a)								
Mt. Whitefish								
Sucker								
Sculpin								
Squawfish								
Tailed Frog								
Spotted Frog								
Western Toad								
OTHER?								

APPENDIX 7

Photos from 2000 Bull Trout Surveys in the Snoqualmie Watershed

Thermograph housing

Hardscrabble Creek native cutthroat trout

Snorkel survey in the South Fork of the Snoqualmie River

Pacific Giant Salamander caught in Burntboot Creek

Pool on the Middle Fork of the Snoqualmie River

Burntboot Creek

Headwater areas of the Middle Fork of the Snoqualmie River

Denny Creek Snorkel Survey